Executive Summary

The 1989 Report on Orbital Debris noted the lack of definitive measurements on the debris environment. Since that time NASA, with the assistance of DOD, has conducted an extensive program to measure the LEO debris environment. There has now emerged a comprehensive picture of the orbital debris environment in LEO. The current Haystack measurements indicate populations a factor of two lower than predicted in 1989 at Space Station altitudes and a factor of two higher at the 1000 km altitude. In GEO, however, NASA has only conducted an exploratory campaign to measure the debris environment. Both of these efforts should continue in order to refine our understanding of the current environment as well as to monitor changes in the environment with time.

Contributions to the current debris environment continue to be essentially proportional to the level of space activity by a given spacefaring nation. Of particular concern is the sustained rate of fragmentation events since 1989 despite the active efforts of the spacefaring nations to reduce the probability of such occurrences.

The orbital debris environment in LEO continues to present problems for space operations that involve large spacecraft in orbit for long periods of time. Taking note of all that has been learned since 1989, the International Space Station Program has taken steps to maximize protection from debris penetration by implementing state-of-the-art shielding; utilizing existing ground radars to track and avoid larger debris; and actively developing operational and design options which will minimize the risk to the crew and the Station.

Since release of the 1989 Report, there have been a series of proposals to develop large LEO satellite constellations. These constellations could present a significant new concern for the orbital debris environment. For those constellations which have a large aggregate area, the collision probabilities are sufficiently high that additional means of protection need be considered. The problem is particularly acute because the high inclination of their orbits lead to high spatial density over the poles.

The development and utilization of predictive models has improved significantly since 1989. This improved predictive capability when combined with our increased knowledge of the debris environment, leads to the conclusion that failure to take any mitigation action could lead to significant increase in orbital debris in the coming years. Assuming a continuation of launch activity at the same average rate as over the last ten years, average future solar cycles, and future operational practices that will minimize but not eliminate the possibility of explosions in orbit, most models predict that an increasing fraction of future debris will originate from breakups due to random collisions between orbiting objects. The use of operational practices to limit the orbital lifetime of spent upper stages and payloads have the potential to mitigate the growth of orbital debris.

In 1989 National Space Policy Directive-1 (NSPD-1) was approved. NSPD-1 called for agencies to "seek to minimize the creation of space debris." Since that time orbital debris concerns have caused changes in the plans and activities of some agencies, particularly NASA. NASA has issued a comprehensive agency policy concerning orbital debris. The Department of Defense (in particular the Air Force and the U.S. Space Command) have adopted broad policies concerning orbital debris. Beyond the general statement in NSPD-1, there remains no comprehensive statement of USG policy on orbital debris.

The 1989 Report called for NASA and the DOD to develop a plan to monitor the orbital debris environment. Since that time NASA, utilizing many DOD assets and NASA's own capabilities, has expended considerable effort to accomplish this recommendation. The modification of the Haystack Radar for orbital debris measurements has greatly enhanced our ability to monitor the LEO debris environment. Today, data measurements as well as data management limitations significantly affect the capability of the Space Surveillance Network to detect and track smaller debris objects. Statistical techniques are being utilized to characterize the current debris population.

Since the publication of the 1989 Report, the United States and a number of national and international spacefaring organizations have begun to address orbital debris concerns. As a result of the recommendations set out in the 1989 Report, the United States and other spacefaring nations have taken voluntary design measures (i.e., tethering of operational debris such as lens caps and the use of debris free devices for separation and release) as well as operational procedures to prevent the generation of orbital debris. More than ever, it is clear that closer international cooperation is necessary for dealing effectively with orbital debris. It is in the broad interest of the United States to continue to maintain a leadership role in international considerations relating to orbital debris. The United States considers the development of technical cooperation and consensus to be a prerequisite for any potential international agreements, regulatory regimes or other measures relating to orbital debris. The unilateral application of debris mitigation measures could put U.S. satellite and launch vehicle industries at a competitive disadvantage.

Five specific recommendations are proposed to address issues raised in this report. They are:

1. Continue and enhance debris measurement, modeling and monitoring capabilities;
2. Conduct a focused study on debris and emerging LEO systems;
3. Develop government/industry design guidelines on orbital debris;
4. Develop a strategy for international discussions; and
5. Review and update U.S. policy on debris.